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The Challenges of Using Real-Time Detection Systems: From Data Gathering to Actionable Information

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Dina Siegel

- Speaker Bio
  - Dina has over 30 years' experience in comprehensive industrial hygiene practice, as a manager, and as a field industrial hygienist, Biosafety Officer, and Chemical Hygiene Officer.
  - She has been employed by the Department of Army and as a consultant for both private industry and government. She has worked as a contractor for the Department of Energy at Rocky Flats, and is currently at Los Alamos National Laboratory.
  - She has experience in all aspects of industrial hygiene and several safety topics, and has technical expertise in chemical safety and management, exposure assessment and biosafety.

Overview of This Session

This session will discuss challenges and real life examples associated with Real-Time Detection Systems (RTDS) used in exposure assessment strategies. This first presentation will provide an overview of RTDS as used as part of an overall exposure assessment strategy and to document regulatory compliance. Managing OH consequences has been problematic when it comes to actionable information gleaned from sensor data. The judgement of regulatory entities, can be at odds with IH practitioners implementing an exposure strategy that creates exposure profiles and judges workplace exposures.

What are RTDS?

- They are industrial hygiene instruments with sensors that can detect a hazard.
- They assist the industrial hygienist in establishing a hazard's presence or absence (i.e., a qualitative result) or provide a concentration (i.e., a quantitative result).
- They include configurable functions such as data logging, intervals, and alarm settings.

How are RTDS used?

- They are traditionally used as screening tools, or for emergency response.
- They can be used to examine within-shift variability of peak exposures for fast acting agents such as hydrogen sulfide.
- They can also be used to demonstrate compliance with OELs.

Why use an RTDS?

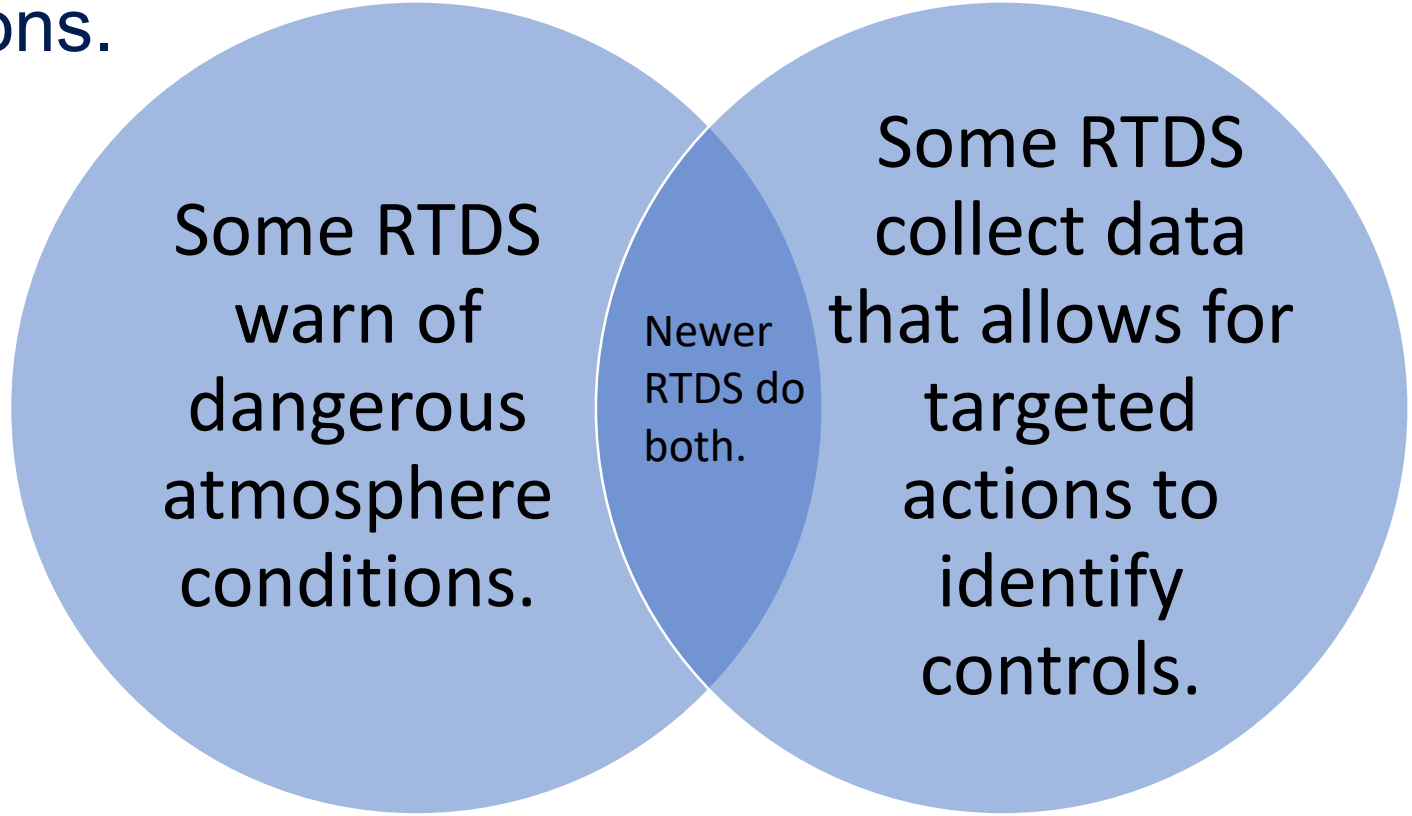
- Workers may vary their behavior from day to day, or may not follow process instructions in a consistent manner from day to day.
- With the addition of variations in process equipment and materials properties, exposure profile variations begin to appear.
- When excursions above an OEL are noted, it is important to address the risk associated with the excursions and determine appropriate actions in the future to avoid or minimize them.

Traditional Use of RTDS

- Grab samples
- Screening samples
- Emergency response

Traditional Use of RTDS

- initially created based on market needs to manage occupational health consequence risks, not to support exposure assessment programs nor compliance demonstrations.



Advantages of RTDS

- Immediate availability of the data.
- Better accuracy and precision than sampling pumps and laboratory analysis in some cases.
- Method performance specified in widely used laboratory methods is +/- 25%. Many RTDS claim best-case accuracy of better than 1%.
- Ability to data log and provide an exposure profile over the sample period.

Occupational Exposure Assessment

- The degree and variability of workplace exposures to hazards.
  - R=*f* (hazard magnitude) X (health consequence).
- Comparing results to an OEL with one or more sample results.
  - Straight comparison of OEL to a result
  - Use of an exposure control categories
  - Use of statistical analysis

Regulatory compliance

- Regulatory interpretations grounded in updated legal precedent are lacking.
- As a result, some practitioners believe that any data point recorded above the OEL is a de facto demonstration of non-compliance, regardless of
  - the time interval of the recorded data point, or
  - the linkage of that datum to the evidence of a health consequence.

Regulatory compliance

- These beliefs lead to real implications for industrial hygienists such as:
  - abandoning technical toxicological foundations for the interpretation of information;
  - application of the hierarchy of controls and the resources to implement them when they may not be needed; or
  - overprotection of the employee through assignment of personal protection equipment, resulting in significant costs in work productivity, efficiency, and finances.

Use of RTDS for Compliance

- It must be understood that the values are based on sample results in the worker's BZ and the monitoring capability of the instrumentation.

OSHA Compliance and RTDS

- RTDS are specifically discussed in OSHA standards, e.g., General Industry Confined Space Standard.
- OSHA regulations in general neither require nor prohibit measurement of air contaminants using RTDS for an employer to determine compliance with exposure standards.
- To the degree that RTDS may be used for exposure assessment, they should be embraced and used to the extent of their capabilities, with full understanding of their limitations.

Another regulatory compliance example

- Exposure over the OEL (DOE)* is categorized under Group 2- Personnel Safety and Health 2A(6):
  - (High) Personnel exposure to chemical, biological, or physical hazards that exceed 10 times the limits established in 10 CFR Part 851, Worker Safety and Health Program (see 10 CFR Section 851.23 Safety and Health Standards) or exceed levels deemed Immediately Dangerous to Life and Health (IDLH).
  - (Low) Personnel exposure to chemical, biological or physical hazards above limits established in 10 CFR Part 851, Worker Safety and Health Program (see 10 CFR Section 851.23, Safety and Health Standards), but below levels deemed IDLH.

* DOE Order 232.2a, Occurrence Reporting and Processing of Operations Information

Occupational Exposure Limits

- TWA – Time-Weighted Average (TWA) exposures are used to assess risk of chronic ill health effect over prolonged periods of time, generally 8 hours.
- An averaged concentration obtained over any time period is actually a TWA value. For example, a 15-minute STEL sample collected using a sampling pump and sampling medium provides a 15-minute TWA exposure value.

Occupational Exposure Limits

- Ceiling – A ceiling limit is generally accepted as a value which should not be exceeded at any time.
  - Values related to ceiling limits are generally based upon a minimum sample volume.
  - Minimum sample volumes are specified in OSHA Ceiling Limits.
- STEL - used to address acute health effects such as irritation when chronic health effects may also be expected.
  - Example: many organic vapors, which may be irritating at high levels, may also cause disease within a target organ with lower exposure levels over prolonged periods (e.g., months or years).

Occupational Exposure Limits

- Excursion – OSHA defines an excursion limit as a 15-minute or a 30-minute TWA exposure that must not be exceeded at any time. In the asbestos expanded standards for construction and general industry, the excursion limit is a concentration that must not be exceeded over a 30-minute period. In the ethylene oxide general industry standard, the excursion limit is a concentration that must not be exceeded over a 15-minute period.

Occupational Exposure Limits

- Immediately Dangerous to Life or Health (IDLH) - an atmospheric concentration of any toxic, corrosive or asphyxiant substance that:
  - poses an immediate threat to life or
  - would cause irreversible or delayed adverse health effects or
  - would interfere with an individual's ability to escape from a dangerous atmosphere.

Occupational Exposure Limits

- Peak Exposure - typically considered the highest recorded data point within a defined set of data.
- OSHA (29 CFR 1910.1000, Table Z-2) also uses the term “acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift” in a unique regulatory sense for a select group of chemicals with regulatory OEL values derived from 1960s era American National Standards Institute (ANSI) standards.

Peak Exposures are of concern

- There are agents with rapidly occurring acute adverse health effects
  - Many have established STEL or ceiling value.
  - For those without a TLV-STEL or TLV-C, ACGIH uses the 3/5 rule.

Use and Limitations of RTDS

- Always review specifications[1] before use
  - information specifications
  - performance specifications
  - operation specifications
  - readings specifications
  - interference specifications
  - maintenance specifications
  - data management specifications
  - safety specifications

[1] Reporting Specification for Electronic Real Time Gas and Vapor Detection Equipment, Fact Sheet sponsored by the AIHA Real Time Detection Systems Committee, October 17, 2016.

Sensors evaluate:

- Selectivity
- Accuracy, precision and repeatability
- Effect of environmental conditions on sensor performance
- Known inherent characteristics of the sensor

Data Logging

- Document peak exposures.
- Demonstrate compliance with ceiling limits.
- Characterize tasks that have variable exposures.
- Useful in situations where the industrial hygienist is not able to be near the task (e.g., limited space, additional exposure risk) or when variable exposures are difficult to manually document in real time.

Data Logging

- Variables:
  - Where the data is stored
  - How often the data is recorded
  - Format of data
- Data collected during sampling would likely be considered an employee exposure record per 29 Code of Federal Regulations (CFR) 1910.1020 (Access to Employee Exposure and Medical Records) and would need to be preserved and maintained for the appropriate length of time.
- The DOE also requires that all RTDS readings used for evaluating personal exposures must be retained in accordance with the DOE Epidemiological Moratorium.

Alarm Set Point Considerations

- Duration of the exposure
- Type of monitor and its capabilities (integrating or instantaneous direct reading)
- Location and type of sampling (e.g., breathing zone (BZ) or area)
- Goal of the sampling (e.g., personal evaluation, confirmation of adequacy of controls)
- OEL
  - type of monitoring conducted, instantaneous or integrated
  - duration of the task
  - goal of the monitoring

Additional Alarm Set Point Considerations

- PELs, TLVs, STELs, and peaks have an integrated time-weighted aspect to them. These values can be exceeded if the value over the applicable time frame is not exceeded.
- The chosen alarm level should be set at a low enough level to ensure the protection of the workers yet high enough to avoid spurious alarms that can be caused by temporary fluctuations in air concentrations, or fluctuations due to environmental changes (humidity, temperature, or pressure).

Additional Alarm Set Point Considerations

- Multiple strategies may be employed when setting an alarm set point. For example, the low alarm may be set at a percentage of the 8-hour TWA while the high alarm is set at a percentage of the STEL.

Temporal Variability

- RTDS allow exposure excursions above a target value to be readily identified, whereas integrated sampling onto a medium (generally analyzed in a laboratory) provides information only about the average exposure across the full sample collection period.

Documentation/Reporting

- Monitoring results should be documented and retained as part of the assessment of workplace hazards. The DOE, in the promulgation of the Worker Safety and Health Program, 10 CFR 851, mandates that contractors must:
- 1) 10 CFR 851.21(a)(2) Document assessment for chemical, physical, biological and safety workplace hazards using recognized exposure assessment and testing methodologies,
- 2) 10 CFR 851.21(a)(3) Record observations, testing and monitoring results, and
- 3) 10 CFR 851.26(a)(1) Establish and maintain complete and accurate records of all hazard inventory information, hazard assessments, exposure measurements, and exposure controls.

Peak Exposure Data Interpretations

- The interpretation of data against instrument configured alarms and data logging parameters should reflect all relevant limits addressing Immediately Dangerous to Life and Health (IDLH), Ceiling (TLV-C, Calculated TLV-C [from the “3/5” Rule] or PEL-C), or STEL (TLV-STEL, Calculated TLV-STEL [from the “3/5” Rule] or PEL-STEL).
- Data interpretations should exist for single datum, grouped data, or SEG-linked data. These data interpretations are necessary to comply with 10 CFR 851.21 requirements for exposure assessment.
- The sum of all the determinations made by the industrial hygienist around instrument selection, data logging parameters, and data interpretation should be transparent to all stakeholders.

A PRACTICAL GUIDE FOR USE OF REAL TIME DETECTION SYSTEMS FOR WORKER PROTECTION AND COMPLIANCE WITH OCCUPATIONAL EXPOSURE LIMITS

Prepared by:

Energy Facility Contractor's Group (EFCOG) Industrial Hygiene and Safety Task Group and Members of the American Industrial Hygiene Association (AIHA) Exposure Assessment Strategies Group

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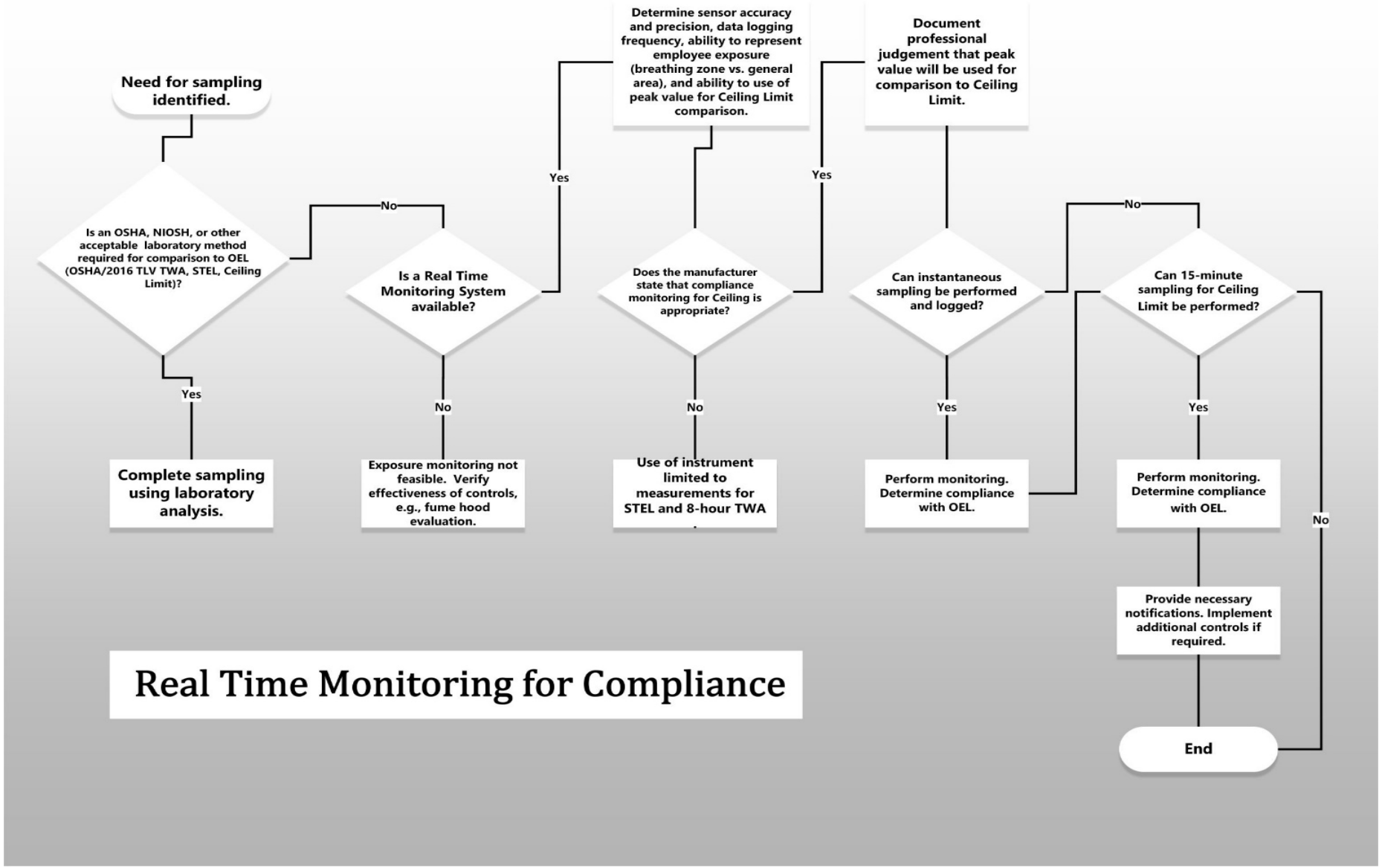
Focus of White Paper

- Protection of worker health.
- Solid exposure decisions based on occupational exposure limits (OELs).
- Successfully managing compliance with applicable regulations.


Need for sampling identified.
Is an OSHA, NIOSH, or other acceptable laboratory method required for comparison to OEL (OSHA/2016 TLV TWA, STEL, Ceiling Limit)?
Yes
Complete sampling using laboratory analysis.
No
Is a Real Time Monitoring System available?
No
Exposure monitoring not feasible. Verify effectiveness of controls, e.g., fume hood evaluation.
Yes
Determine sensor accuracy and precision, data logging frequency, ability to represent employee exposure (breathing zone vs. general area), and ability to use of peak value for Ceiling Limit comparison.
Does the manufacturer state that compliance monitoring for Ceiling is appropriate?
No
Use of instrument limited to measurements for STEL and 8-hour TWA
Yes
Document professional judgement that peak value will be used for comparison to Ceiling Limit.
Can instantaneous sampling be performed and logged?
Yes
Perform monitoring. Determine compliance with OEL.
No
Can 15-minute sampling for Ceiling Limit be performed?
Yes
Perform monitoring. Determine compliance with OEL.
Provide necessary notifications. Implement additional controls if required.
End
No
Real Time Monitoring for Compliance

Thank You

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